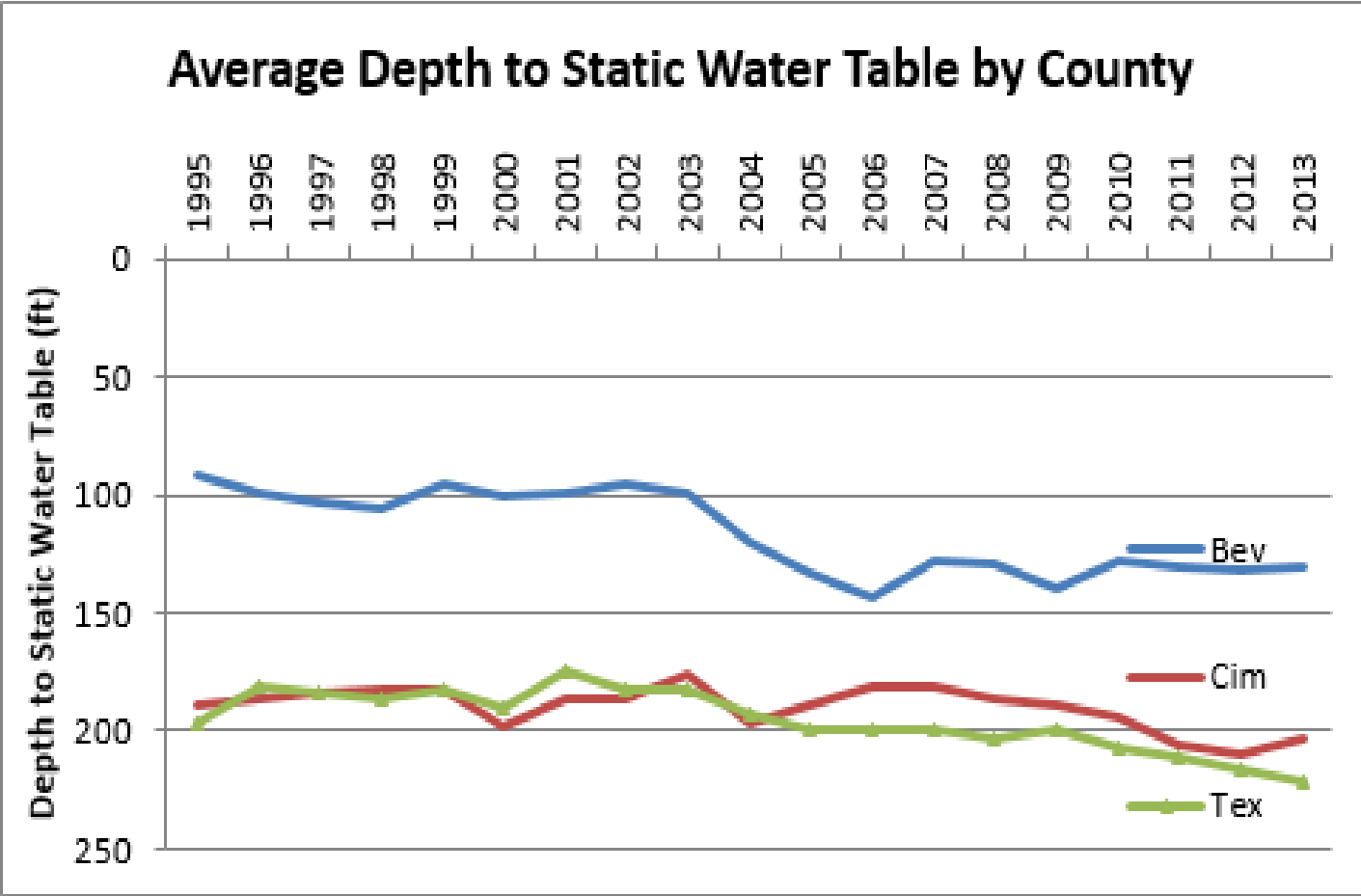


Economic Modeling to Maximize the Remaining Value of Ogallala Groundwater with Irrigated Corn VS Grain Sorghum and Center Pivot VS Subsurface Drip Systems

Governor's Water Conference, December 2, 2015

- ▶ Arthur Stoecker, Associate Professor, OSU Dept. of Ag. Economics
- ▶ Karthik Ramaswamy, Research Assistant, OSU Dept of Ag. Economics
- ▶ Jason Warren, Associate Professor, OSU Dept. of Plant and Soil Science
- ▶ Rodney Jones, Professor, OSU Dept of Ag. Economics
- ▶ Jody Camphice, former Professor, OSU Dept of Ag. Economics
- ▶ Andrew Paul, Research Assistant, OSU Dept of Ag. Economics
- ▶ Brooke Lane, Research Assistant, OSU Dept of Ag. Economics

Water Table in Ogallala Panhandle has been Declining by 0.9 to 2.6 FEET/YEAR



Average Annual Decline	
County	(ft/year)
Beaver	2.6
Cimmaron	0.9
Texas	1.9

As reported by the USGS



Study Objectives

Major objective:

To determine maximum returns from remaining ground water supply.

Specifically to compare:

- ▶ Long-term values and aquifer life with center pivot irrigated corn.
- ▶ Long-term values and aquifer life with subsurface drip irrigated corn.
- ▶ Long-term values and aquifer life with center pivot irrigated grain sorghum.
- ▶ Long-term values and aquifer life with subsurface drip irrigated grain sorghum.



Study Methods

EPIC Simulation with 50 Years of daily Goodwell Weather to extend research and estimate mean yields under alternative irrigation levels.

Calibrate Simulated Yields to OPREC results

Use MIP (CPLEX) Multiperiod Programming Model to determine Maximum Discounted Net Returns from a finite groundwater supply over Planning Horizons from 30 to 60 years

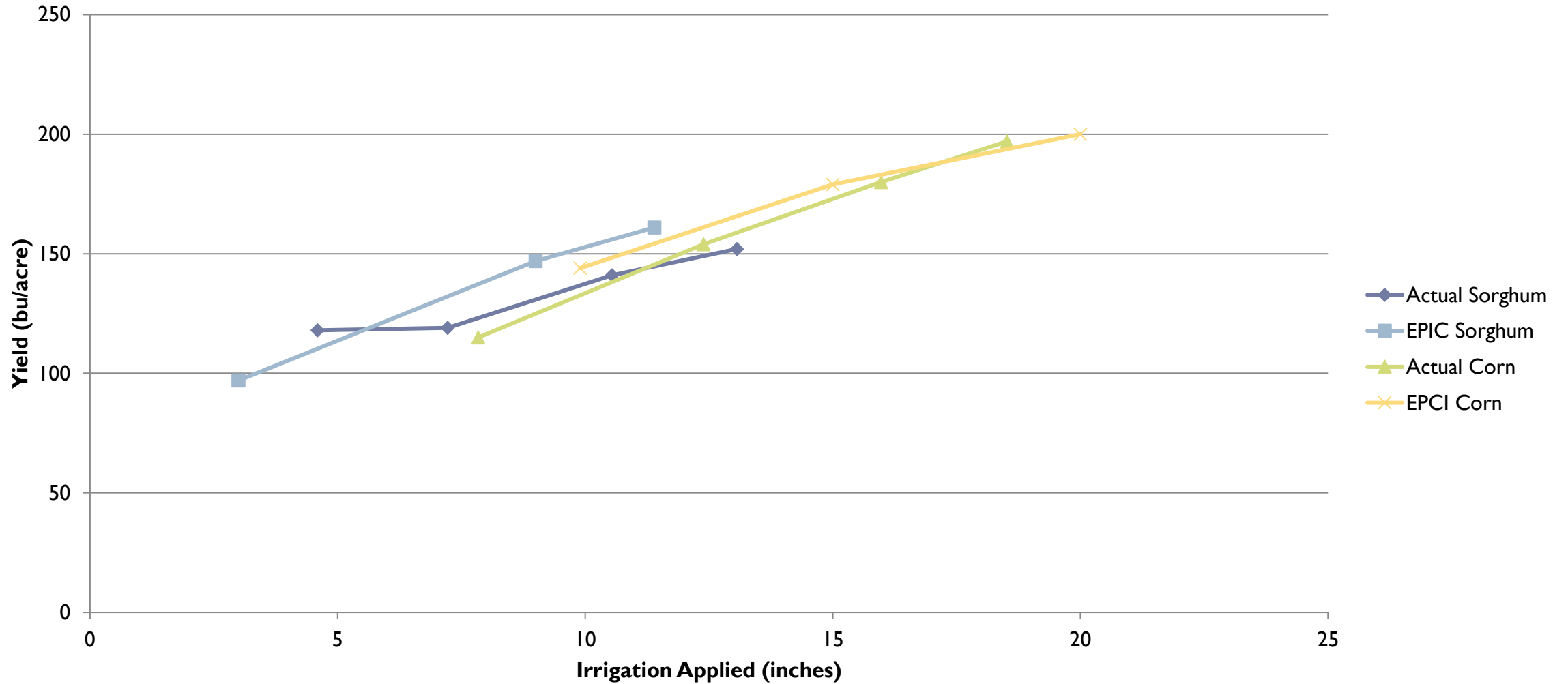


Simulation of Deficit Irrigation on Corn by Center Pivot

Days to Apply 1.42"		Deficit Irrigation Simulated by Delaying Next Irrigation Until						
Well	Days	Remaining Percent Soil Moisture Declined to						
Size	per	30%	40%	50%	60%	70%	80%	90%
GPM	Circle	Average Annual Gross Irrigation on Corn (acre inches)						
800	4	14.6	15.3	16.2	18.8	21.5	22.5	22.5
700	5	14.6	15.3	16.1	18.0	20.4	22.1	23.1
600	6	14.6	15.0	15.9	17.2	19.0	20.4	21.6
500	7	14.1	14.6	15.3	16.0	17.4	18.6	19.5
400	8	13.5	13.9	14.4	15.0	15.9	17.0	17.6
300	11	11.0	11.3	11.8	12.3	12.8	13.4	13.9
200	16	8.7	8.8	9.1	9.4	9.7	10.1	10.3
100	32	5.4	5.5	5.7	5.8	5.9	6.0	6.1

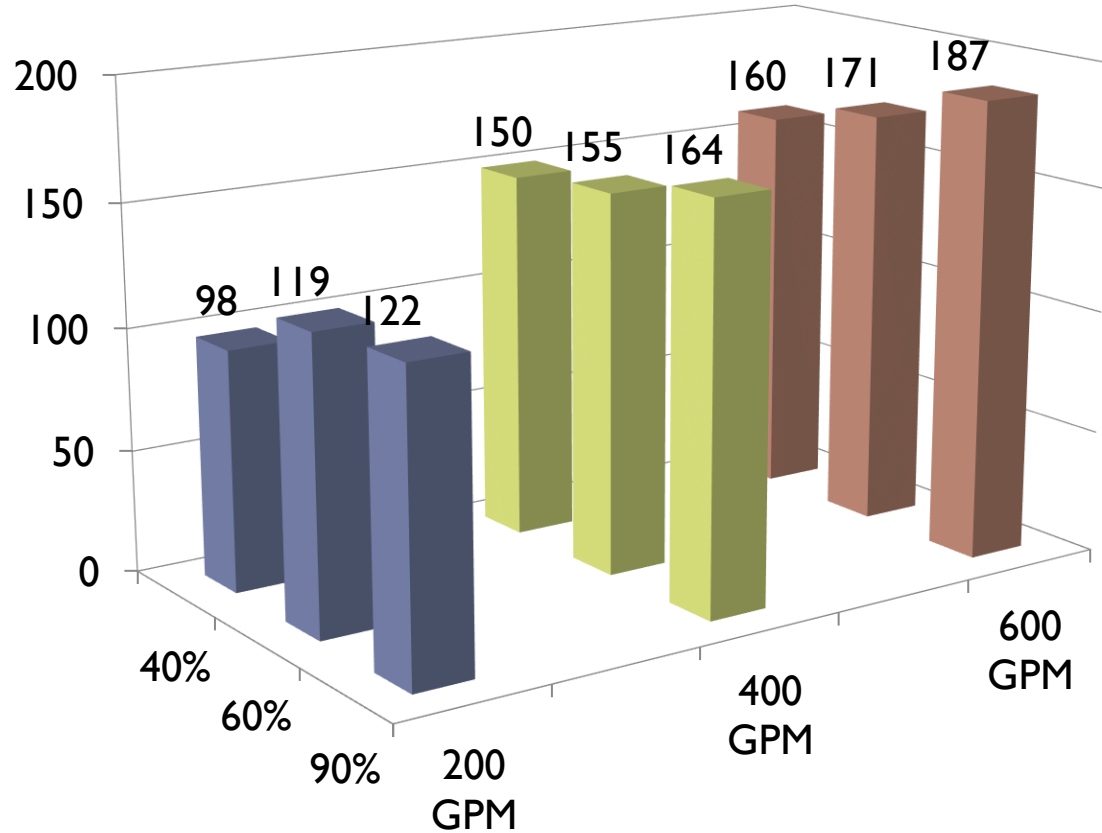


Actual 3-yr average yield and irrigation vs simulated results for Corn and Sorghum

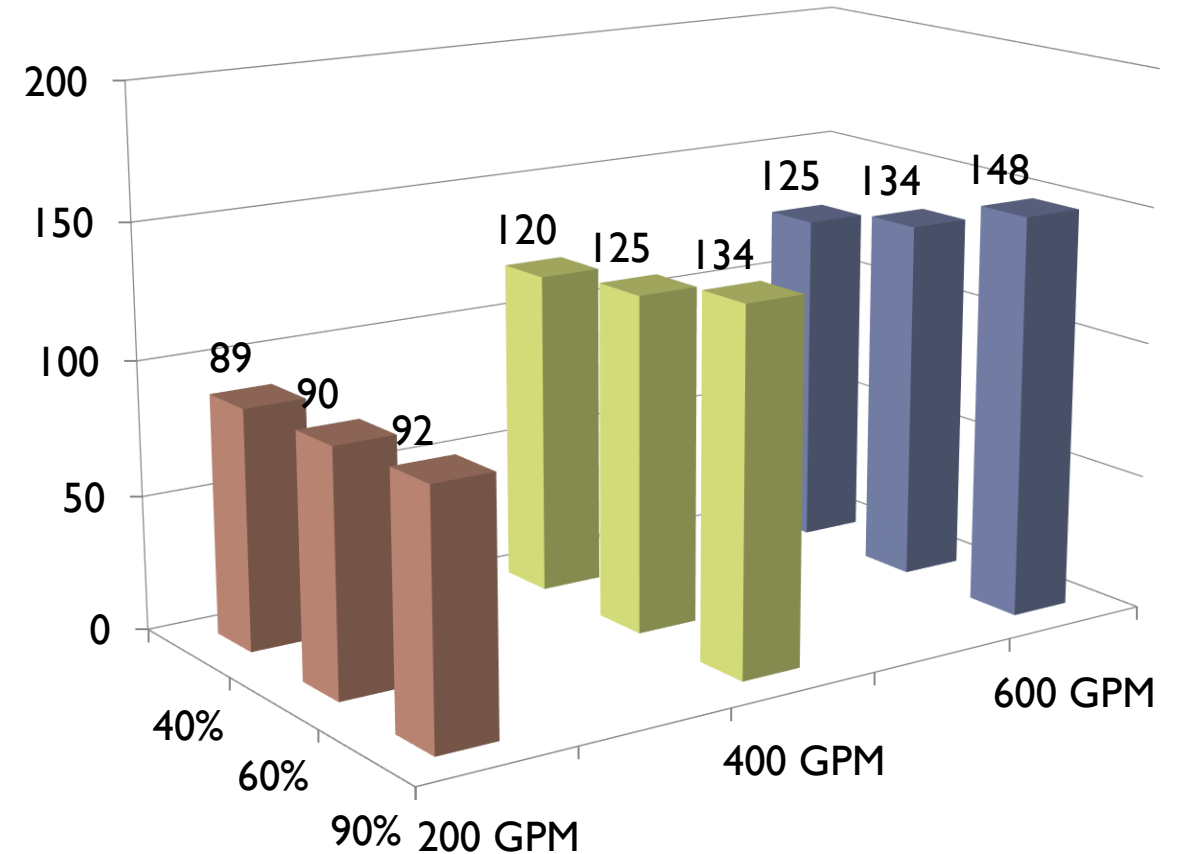


Results from EPIC Simulation of 120 Acre Center Pivot Yields and Irrigation Rates

CP CORN YIELDS



CP GRAIN SORGHUM YIELDS



Net Returns from Irrigated Corn and G. Sorghum with SDI and CP

Irrigated Corn

	600 GPM		400 GPM		200 GPM	
	SDI	CP	SDI	CP	SDI	CP
Yield (bu/ac)	202	182	179	159	144	119
Net Rev.	\$ 905	\$ 814	\$ 800	\$ 712	\$ 645	\$ 535
Tot. VC	\$ 678	\$ 649	\$ 622	\$598	\$546	\$509
Ann Sys Cost	\$ 65	\$ 45	\$ 65	\$ 45	\$ 65	\$ 45
Net Ret-Sys. Cost	\$ 162	\$ 120	\$ 113	\$ 69	\$ 34	\$ (20)
Ac. Inch/ac	20	24.2	14.9	14.9	9.9	8.6
Net Rev./ Ac. In.	\$8	\$5	\$8	\$5	\$3	(\$2)

Irrigated Grain Sorghum

600 GPM		400 GPM		200 GPM	
SDI	CP	SDI	CP	SDI	CP
161	146	147	131	97	92
\$670	\$608	\$612	\$544	\$402	\$384
\$18	\$444	\$18	\$410	\$14	\$324
\$65	\$45	\$65	\$45	\$65	\$45
\$141	\$119	\$116	\$90	\$11	\$15
11.4	10.6	9.0	8.7	2.9	3.4
\$12	\$11	\$13	\$10	\$4	\$4



Annualized cost of \$90,700 SDI and \$60,100 CP at 4% over 15 years

Example Farm

Single Quarter or 640 Acre (with tied wells)

600 GPM initial well capacity

Surrounding area Fully or 50 % Irrigated

Prices

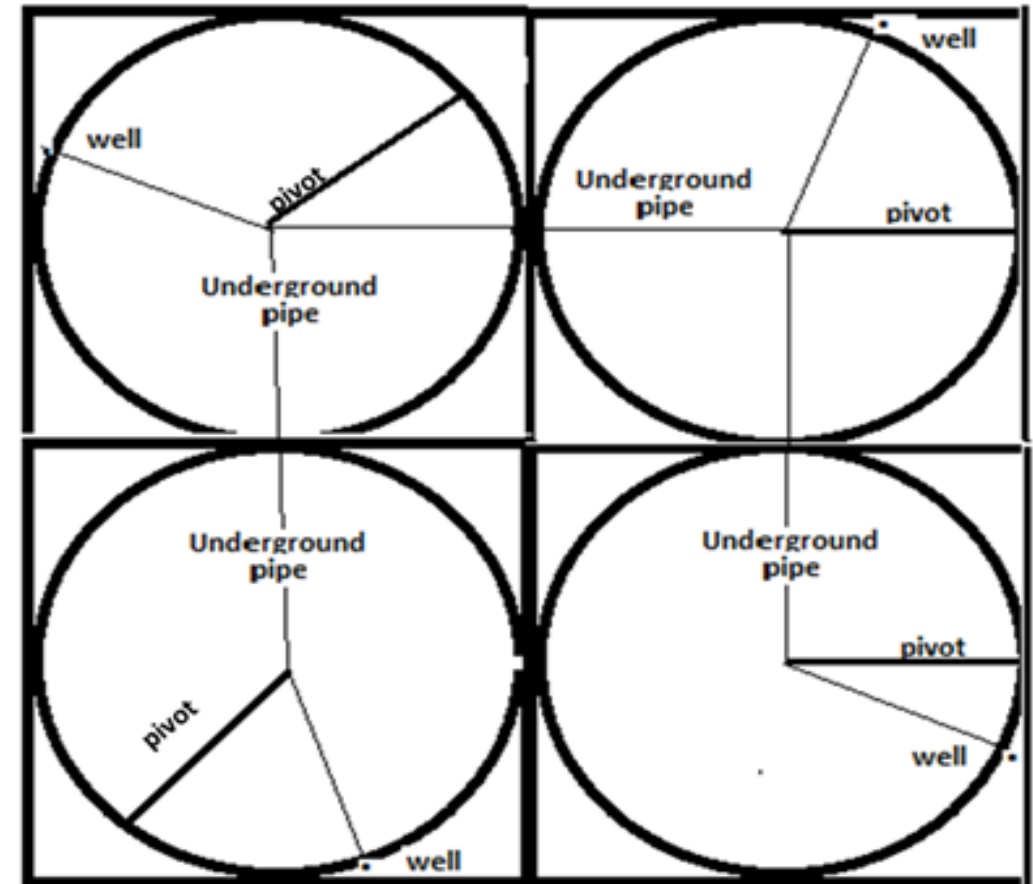
	Corn	Sorghum
Low	\$4.48/bu	\$4.16/bu
High	\$5.48/bu	\$5.09/bu
DiscRate	4% and 7%	

Center Pivot 120 acres @ \$60,100, 15 year life, 85%ef

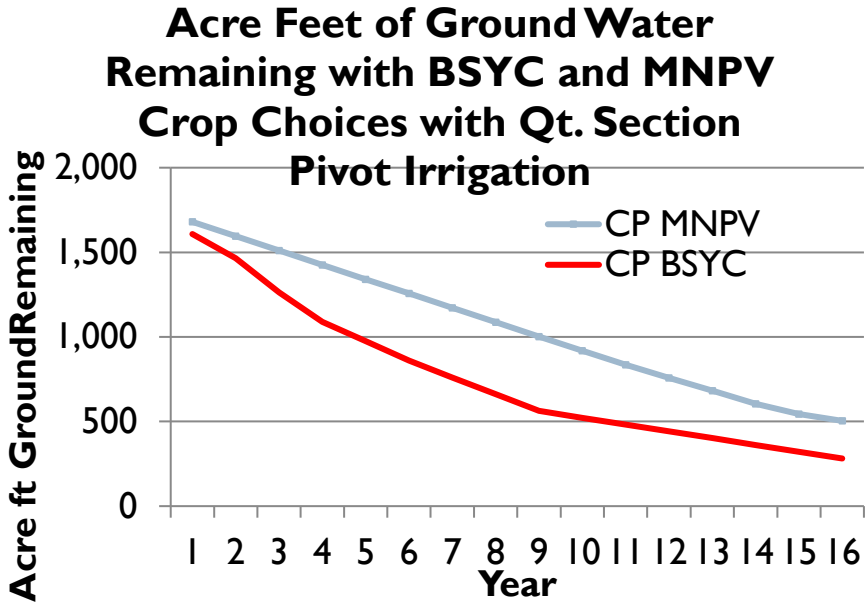
SDI 15 year life, 95% ef

50 acre	\$ 43,000
75 acre	\$ 58,000
100 acre	\$ 74,300
125 acre	\$ 90,700
150 acre	\$107,00

Fully Irrigated Section with Four Tied Wells

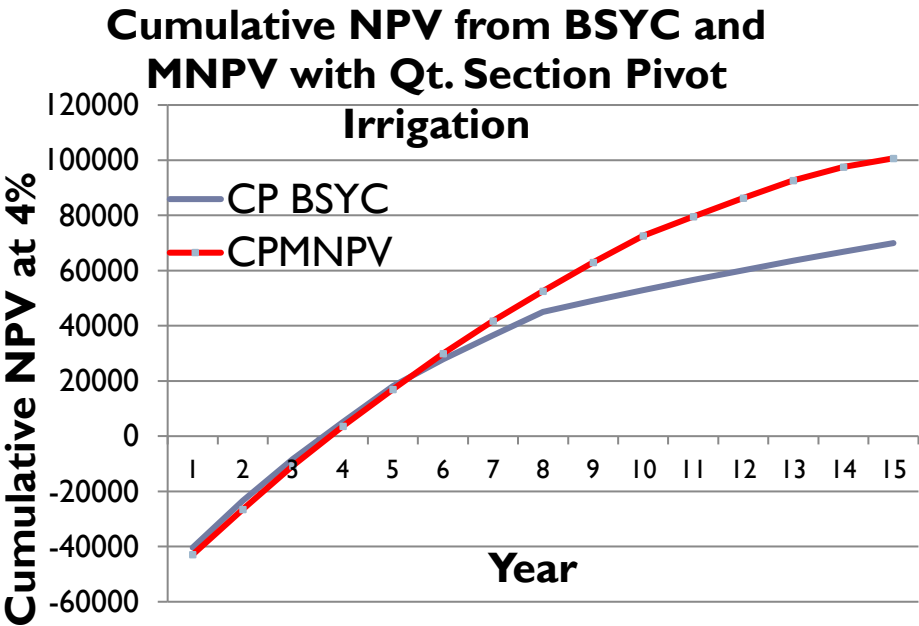
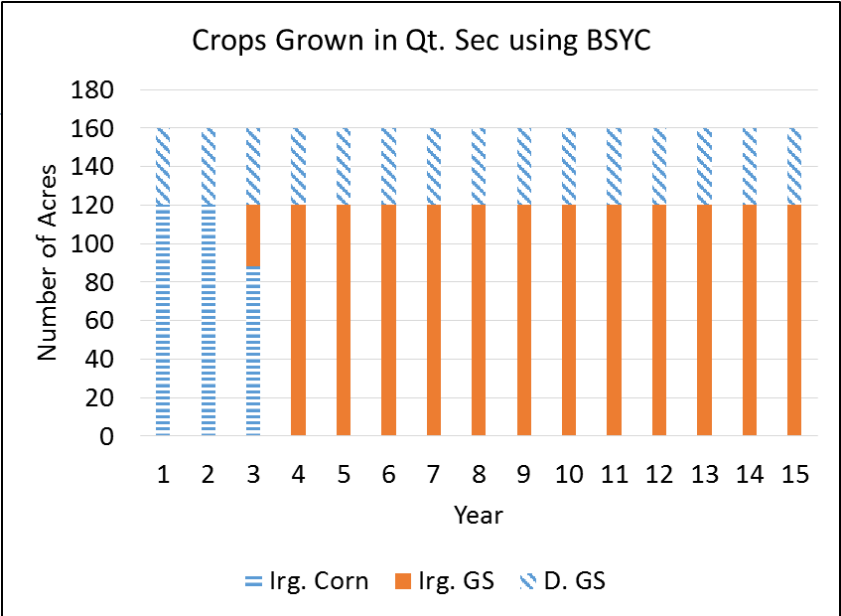


BSYC & MNPV Strategies for 160 Acres with C.Pivot & Limited Groundwater

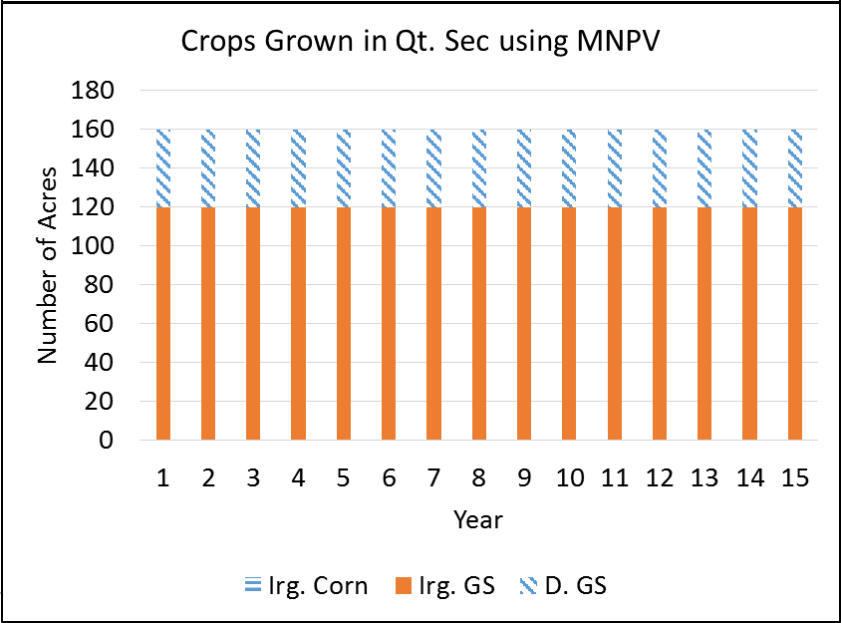


Strategy

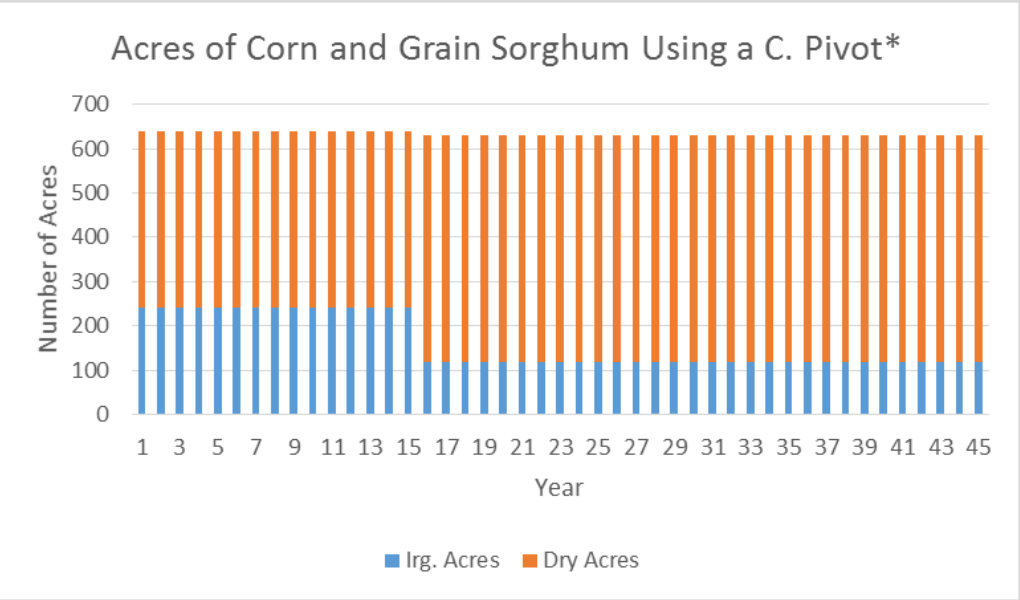
BSYC: Select crop & irrigation that maximizes current return to acre



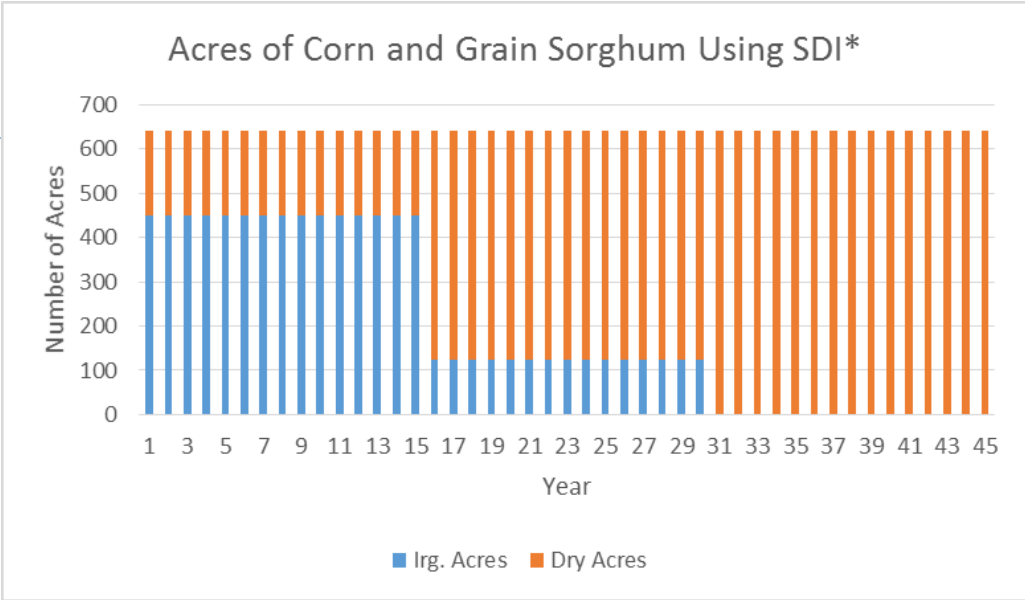
MNPV: Select crop & irrigation to maximize discounted 15 year profits



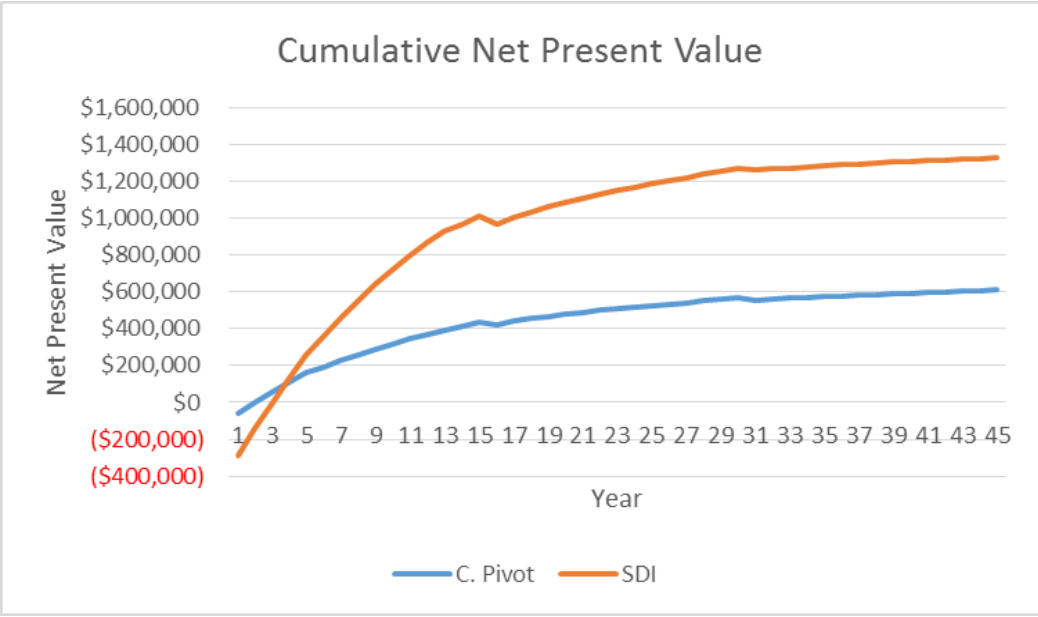
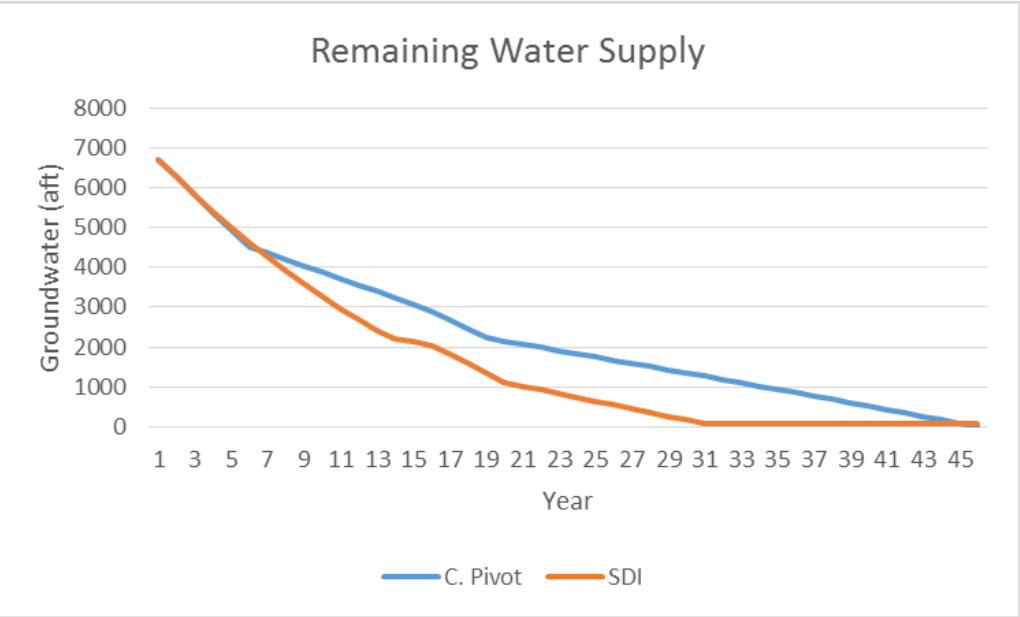
Corn and Grain Sorghum over a 45 year time period



*Corn was produced in years 1-4 and 16-18

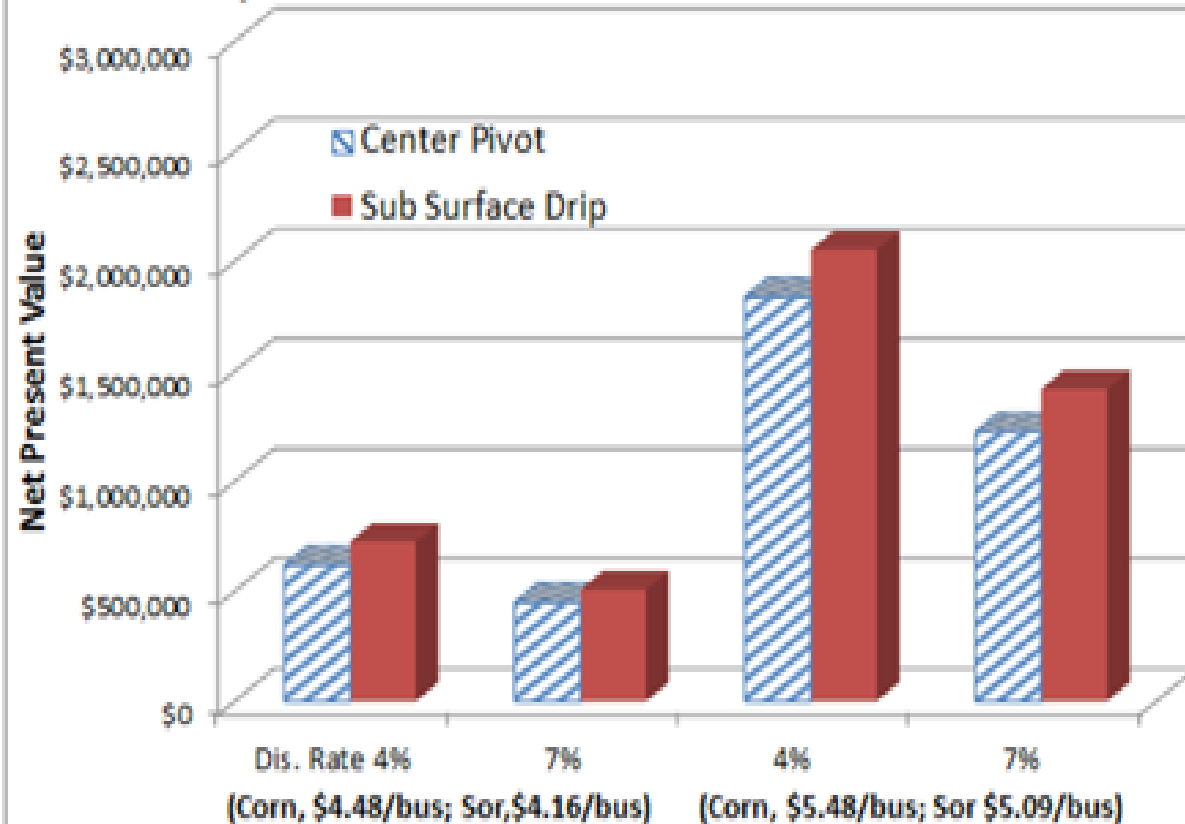


*Corn was produced in years 16-18

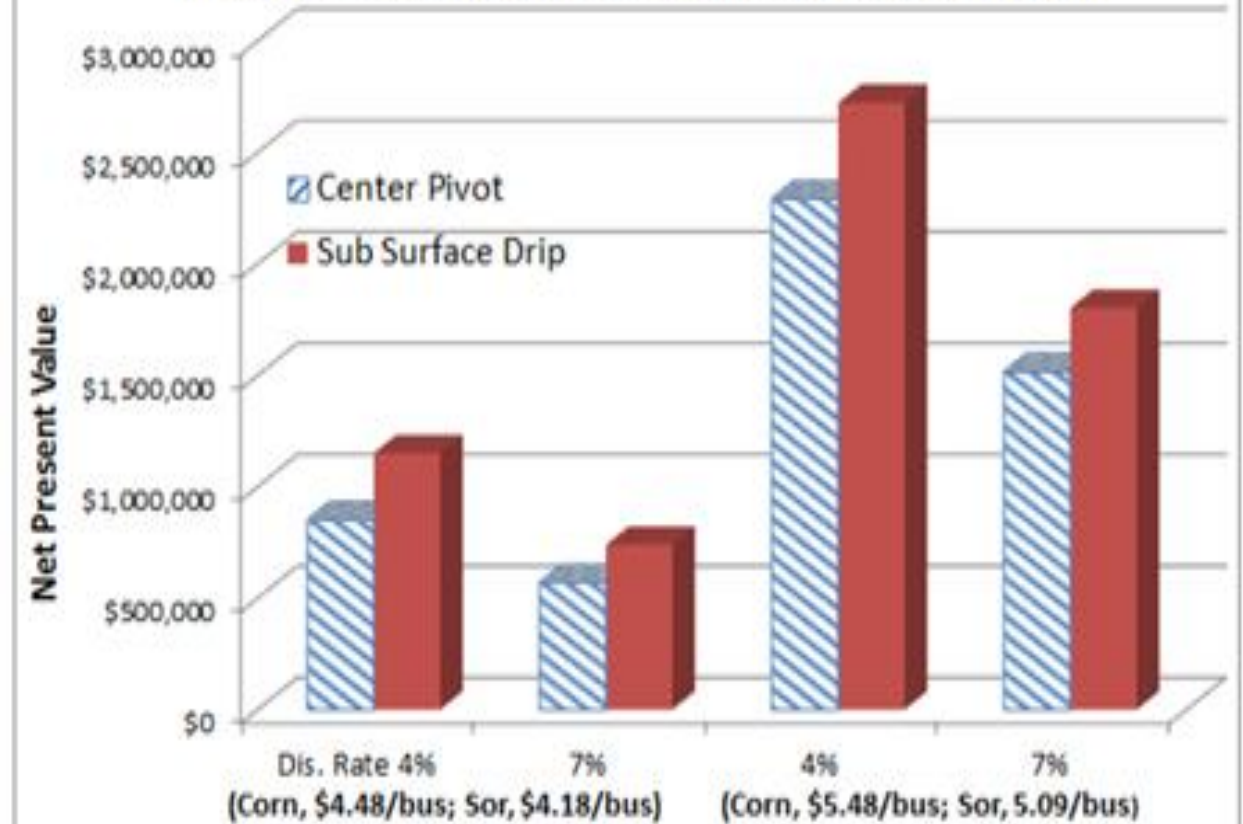


Effect of Price & Surrounding Irrigation on NPV from CP & SDI Investments

Feed Grain Price Effect on 60 Year NPV from 640 Acre Field with 6,270 af from Center Pivot and Sub Surface Drip Investments at Four and Seven Percent Discount

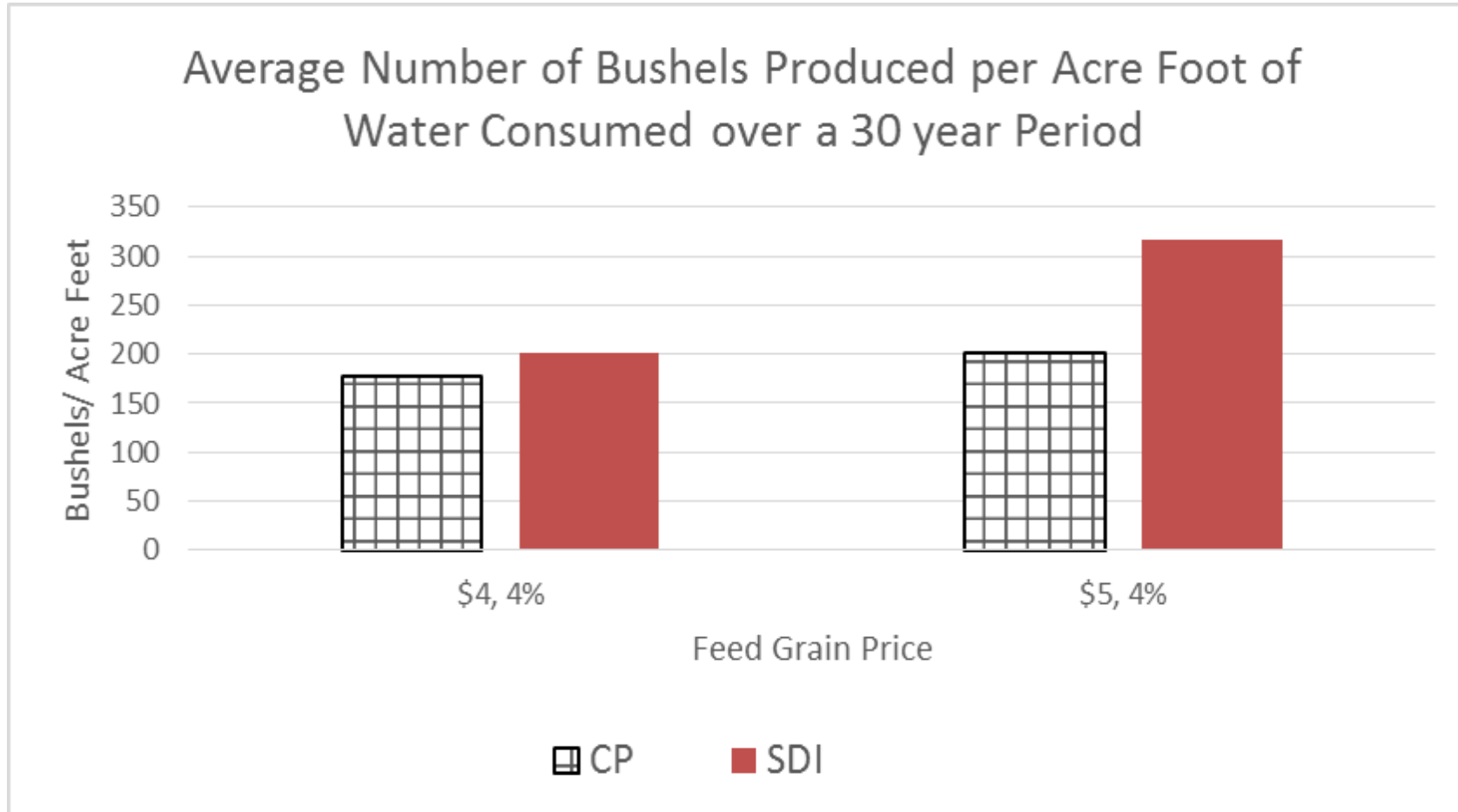


Feed Grain Price Effect on 60-Year NPV from 640 Acre Field with 13,440 af, from Center Pivot and Sub Surface Drip Investments at Four and Seven Percent Discount



Conservation as Maximum Benefit Use of Remaining Groundwater CP VS SDI

Example Irrigation of Grain Sorghum, quarter Section with a 30-year Planning Horizon



SDI did not always result in longer aquifer life but resulted more production per unit of groundwater

Conclusions

- ▶ Long term Profit Maximization Better than BSYC
- ▶ Sorghum more profitable than corn when well capacity is 600 GPM or less
- ▶ SDI more profitable than Conventional CP

